Preliminary Results
Safe Flight 21 - Cost/Benefit Team
Briefing to the SF21 Steering Committee

Outline

- Objective
- Costs
- Benefits
- Economic Analysis Results
- Next Steps

Objective

- Develop ROM estimate of Limited Deployment (LD) costs and benefits for input to the FAA FY02 budget process

SF 21 Limited Deployment: Cost Estimate Overview

- Purpose:
  - Develop FY02-06 F&E budget “wedge” for Safe Flight 21 limited deployment
- Costs reflect currently envisioned operational concepts and SF21 architecture
- Limited Deployment Scope:
  - Ohio River Valley (ORV)
    - Single/multiple data links (6 scenarios)
  - State of Alaska (AK)
- FAA Life Cycle Funding
  - Facilities and Equipment (F&E)
  - Operations and Maintenance (O&M)
- Industry equipage and maintenance costs
- Industry and FAA sunk costs prior to FY02 are not included

ORV: Cost Estimate Scope

Cost estimates for:

- Location
  - Memphis
  - Louisville
  - Wilmington
- FAA
  - ADS-B Ground Stations - En Route and Terminal
  - Vehicle ADS-B
  - Avionics Development
  - Automation Interface
  - FIS-B Development/Automated Weather
  - Software Changes
  - TIS-B Development
  - NASA AMES, Program Office Support, and Regional/Tech Center Support

ORV: Cost Estimate Scope (Cont'd)

<u>Cost estimates for</u>:

- Industry
  - Aircraft Avionics Equipage
    - Airborne
    - UPS
    - FedEx

ORV: System Buy Quantities

	Prior Years	FY02	FY03	FY04	FY05	**Total**
FAA						
Surface Requirements						
ADS-B Ground Stations - Enroute		2	3			5
ADS-B/Multilateration System - Terminal*	2	1				3
Vehicle ADS-B Equipage		75	75	75		225
Automation						
Multiprocessor - Enroute**		2				2
Multiprocessor - Terminal	2	1				3
Tower Display (2 per Multilateration System)	4	2				6
INDUSTRY						
Aircraft Avionics Equipage						
UPS	220	28				248
Airborne	4	60	53			117
Fedex	4	75	75	75	78	307

*Each system includes 8 ADS-B ground stations

**Includes format conversion hardware and PAMRI adapter cards

ORV: FAA Cost Summary

FY02-FY11 Current Year $K

	Single Link		Dual Link	
	F & E	**O & M**	**F & E**	**O & M**
Ground Infrastructure	**$8,817**	**$5,555**	**$9,266**	**$5,555**
ADS-B Ground Station - Enroute	$2,300	$2,290	$2,474	$2,290
ADS-B/Multilateration System - Terminal	$5,942	$3,265	$6,217	$3,265
Vehicle ADS-B	$575	N/A	$575	N/A
Avionics	**$1,000**	**N/A**	**$1,000**	**N/A**
Automation Interface	**$906**	**	**$906**	**
Multiprocessor - Enroute	$455		$455	
Multiprocessor - Terminal	$378		$378	
Tower Display	$73		$73	
Automated Weather	**$2,000**	**N/A**	**$2,000**	**N/A**
Software Changes	**$4,600**	**N/A**	**$4,600**	**N/A**
TIS-B Development	**$4,500**	**N/A**	**$4,500**	**N/A**
NASA AMES	**$2,800**	**N/A**	**$2,800**	**N/A**
ORV Program Office Support	**$18,835**	**N/A**	**$18,835**	**N/A**
Regional/Tech Center Support	**$6,238**	**N/A**	**$6,238**	**N/A**
Total	**$49,696**	**$5,555**	**$50,145**	**$5,555**

**Maintenance costs included in ADS-B Ground Station - Enroute

ORV: Industry Aircraft Avionics Equipage Cost Summary

FY02-FY11 Current Year $K

	Quantity		Datalink Cases (To Complete)					
	Prior Yrs	To Complete	1090 Mode S	UAT	VDL4	1090/UAT	1090/VDL4	UAT/VDL4
AIRCRAFT AVIONICS EQUIPPAGE			**$95,374**	**$109,990**	**$117,083**	**$122,713**	**$129,065**	**$135,292**
UPS (Non-TCAS)	**220**	**28**	**$14,836**	**$11,233**	**$14,661**	**$15,770**	**$19,052**	**$15,595**
System Equipment			$4,086	$3,503	$3,794	$4,670	$4,962	$4,378
System Installation			$1,897	$1,751	$2,043	$2,189	$2,335	$2,335
Additional System Costs			$8,852	$5,979	$8,823	$8,911	$11,754	$8,882
Airborne (Non-TCAS)	**4**	**113**	**$30,492**	**$26,113**	**$29,778**	**$34,298**	**$37,369**	**$33,585**
System Equipment			$17,592	$15,213	$16,402	$19,971	$21,161	$18,782
System Installation			$7,732	$7,137	$8,327	$8,922	$9,516	$9,516
Additional System Costs			$5,168	$3,762	$5,049	$5,406	$6,692	$5,287
FEDEX (Hybrid TCAS/ADS-B)	**4**	**303**	**$50,046**	**$72,644**	**$72,644**	**$72,644**	**$72,644**	**$86,113**
System Equipment			$40,773	$52,185	$52,185	$52,185	$52,185	$61,966
System Installation			$652	$8,151	$8,151	$8,151	$8,151	$8,151
Additional System Costs			$8,621	$12,308	$12,308	$12,308	$12,308	$15,995

Alaska: Cost Estimate Scope

<u>Cost estimates for</u>:

- Introduction of new capabilities for aircraft, airports, flight service stations, and additional FAA locations to improve aviation safety and efficiency
- FAA systems
  - ADS-B Ground Broadcast Transceivers
  - Multiprocessors
  - LAAS
  - AWOS
  - Vehicle ADS-B
  - Automation
  - Capstone Program Office Support
- Commercial aircraft avionics equipage
  - General Aviation
  - Air Taxi

Alaska: System Buy Quantities

	Prior Years	FY02	FY03	FY04	FY05	FY06	FY07	**Total**
FAA Requirements								
SURFACE REQUIREMENTS								
Ground Broadcast Transceiver	13*	50	50	50	38			**201**
Multiprocessor	1	3	3	3	3			**13**
LAAS	1	3	3	3	3			**13**
AWOS	14	12	8	8	7			**49**
Vehicle ADS-B	150	470	270	150	114			**1154**
CAPSTONE AIRCRAFT EQUIPAGE**	150							**150**
Industry Requirements								
GA/COMMERCIAL AIRCRAFT EQUIPAGE		750	750	750	750	750	100	**3850**

* R&D Systems

** GA/Commercial Aircraft Equipped by FAA for OpEvals

Alaska: Cost Summary

FY02-FY11 Current Year $K

	UAT DATALINK		
	F&E	**O&M**	**Total Cost**
FAA COSTS			
SURFACE REQUIREMENTS	**$78,787**	**$86,401**	**$165,187**
Ground Broadcast Transceivers	$41,034	$58,014	$99,048
Multiprocessor	$3,599	$1,085	$4,684
LAAS	$9,798	$3,367	$13,165
AWOS	$21,445	$23,934	$45,380
Vehicle ADS-B	$2,910	$0	$2,910
AUTOMATION REQUIREMENTS	**$2,151**	**$0**	**$2,151**
CAPSTONE PROGRAM OFFICE SUPPORT	**$4,183**	**$0**	**$4,183**
OPS PROCEDURES AND CERTIFICATION	**$0**	**$1,515**	**$1,515**
TOTAL	**$85,121**	**$87,915**	**$173,036**
COMMERCIAL COSTS			
AIRCRAFT AVIONICS EQUIPAGE	**N/A**	**N/A**	**$106,043**
System Equipment			$69,176
System Installation			$15,093
Additional System Costs			$21,774

ORV: Detailed CIP Impacts - Current Year $M

Cost Element	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	Total
GROUND INFRASTRUCTURE	**$4.7**	**$2.8**	**$0.8**	**$0.5**		**$8.8**
ADS-B Ground Stations - En Route	$1.0	$1.1	$0.2	$0.1		$2.3
ADS-B/Multilateration Systems - Terminal	$3.5	$1.6	$0.4	$0.4		$5.9
Vehicle ADS-B	$0.2	$0.2	$0.2			$0.6
AVIONICS						
AUTOMATION INTERFACE	**$0.9**					**$0.9**
Multiprocessor - En Route	$0.5					$0.5
Multiprocessor - Terminal	$0.4					$0.4
Displays	$0.1					$0.1
AUTOMATED WEATHER						
SOFTWARE CHANGES			**$2.5**	**$2.1**		**$4.6**
TIS-B DEVELOPMENT		**$2.5**	**$1.0**	**$1.0**		**$4.5**
NASA AMES	**$0.8**	**$0.5**	**$0.5**	**$0.5**	**$0.1**	**$2.4**
ORV PROGRAM OFFICE	**$3.6**	**$3.4**	**$4.1**	**$4.2**	**$2.2**	**$17.5**
REGIONAL/TECH CENTER SUPPORT		**$0.8**	**$1.1**	**$1.4**	**$0.7**	**$4.0**
CIP Profile	**$10.0**	**$10.0**	**$10.0**	**$9.7**	**$3.0**	**$42.7**
CIP Funding	$10.0	$10.0	$10.0	$9.7	**$3.0**	**$42.7**
Delta	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**

ORV: Detailed CIP Impacts (Cont'd)
Current Year $M

Additional Requirements	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	Total
AVIONICS	$1.0					$1.0
AUTOMATED WEATHER	$2.0					$2.0
NASA AMES					$0.4	$0.4
ORV PROGRAM OFFICE	$0.5	$0.8				$1.3
REGIONAL/TECH CENTER SUPPORT	$1.3	$0.6	$0.3			$2.2
Total Required Funding	**$14.8**	**$11.4**	**$10.3**	**$9.7**	**$3.4**	**$49.6**
CIP Funding	$10.0	$10.0	$10.0	$9.7	$3.0	**$42.7**
Delta	**-$4.8**	**-$1.4**	**-$0.3**	**$0.0**	**-$0.4**	**-$6.9**

Alaska: Detailed CIP Impacts - Current Year $M

Phased Annual Costs-Current Year $M	UAT DATALINK					
Cost Element	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	Total
SURFACE REQUIREMENTS	**$13.7**	**$8.9**	**$3.8**	**$3.8**	**$1.1**	**$31.2**
Ground Broadcast Transceivers	$8.5	$8.1	$3.3	$3.3	$1.1	$24.4
Multiprocessor	$0.9					$0.9
LAAS	$2.4	$0.0				$2.4
AWOS	$0.7	$0.1				$0.8
Vehicle ADS-B	$1.2	$0.7	$0.5	$0.4		$2.8
AUTOMATION REQUIREMENTS	**$0.5**	**$0.5**	**$0.5**	**$0.6**		**$2.2**
CAPSTONE PROGRAM OFFICE SUPPORT	**$0.8**	**$0.7**	**$0.7**	**$0.9**	**$0.9**	**$3.9**
CIP Profile	**$15.0**	**$10.0**	**$5.0**	**$5.3**	**$2.0**	**$37.3**
CIP Funding	$15.0	$10.0	$5.0	$5.3	$2.0	$37.3
Delta	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**

Alaska: Detailed CIP Impacts (Cont'd) Current Year $M

Additional Requirements	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	Total
SURFACE REQUIREMENTS	**$6.1**	**$10.4**	**$15.9**	**$14.1**	**$1.1**	**$47.6**
Ground Broadcast Transceivers		$2.1	$7.7	$6.2	$0.6	**$16.7**
Multiprocessor		$0.9	$0.9	$0.9		**$2.7**
LAAS		$2.4	$2.4	$2.5	$0.1	**$7.4**
AWOS	$6.1	$4.8	$4.9	$4.5	$0.4	**$20.7**
Vehicle ADS-B		$0.1				**$0.1**
AUTOMATION REQUIREMENTS						
CAPSTONE PROGRAM OFFICE SUPPORT		**$0.1**	**$0.1**			**$0.3**
Total Required Funding	**$21.1**	**$20.5**	**$21.1**	**$19.4**	**$3.1**	**$85.1**
CIP Funding	$15.0	$10.0	$5.0	$5.3	$2.0	$37.3
Delta	**-$6.1**	**-$10.5**	**-$16.1**	**-$14.1**	**-$1.1**	**-$47.8**

FAA CIP vs. Required F&E Funding-AK
Detailed CIP Impacts - System Buy Schedule

	UAT DATALINK					
System Buy Quantities	**Prior Years**	**FY 2002**	**FY 2003**	**FY 2004**	**FY 2005**	**Total**
SURFACE REQUIREMENTS						
Ground Broadcast Transceivers	13	50	39	12	14	128
Multiprocessor	1	3				4
LAAS	1	3				4
AWOS	14	1				15
Vehicle ADS-B	150	470	230	150	138	1138
AUTOMATION REQUIREMENTS	n/a	n/a	n/a	n/a	n/a	
CAPSTONE PROGRAM OFFICE SUPPORT	n/a	n/a	n/a	n/a	n/a	

Additional Requirements	Prior Years	FY 2002	FY 2003	FY 2004	FY 2005	Total
SURFACE REQUIREMENTS						
Ground Broadcast Transceivers			11	38	24	73
Multiprocessor			3	3	3	9
LAAS			3	3	3	9
AWOS		11	8	8	7	34
Vehicle ADS-B			40			40
AUTOMATION REQUIREMENTS	n/a	n/a	n/a	n/a	n/a	
CAPSTONE PROGRAM OFFICE SUPPORT	n/a	n/a	n/a	n/a	n/a	

General Assumptions

- Timeframe for this analysis FY02-FY11 (10 years)
- All estimates presented are in constant dollars
- Benefit estimates reflect currently envisioned operational concepts and architecture
- Limited Deployment Scope:
  - Ohio River Valley (ORV)
  - State of Alaska (AK)
- Information sources: TAF, CODAS, NCDC, FAA/industry studies
- Tools
  - Analytica: Common data sets, relationship trees, sensitivity analysis
  - NAS queueing model developed by ASD-430
  - Simplified queueing model from Lincoln Labs

Effectiveness

- Effectiveness rates were assumed for each Enhancement based on:
  - Engineering / operational judgement
  - Analysis of comparable technologies when available
- Effectiveness assumptions were based on 100 percent equipage
- Stakeholders are requested to review and comment on assumptions

SF21 Equipage Rates

Equipage Rates

	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11
Limited Deployment										
Capstone	13%	24%	35%	45%	56%	57%	57%	57%	57%	57%
Ohio River Valley (Cargo only)	34%	58%	77%	88%	100%	100%	100%	100%	100%	100%
Ohio River Valley (Cargo & NWA	24%	48%	69%	84%	100%	100%	100%	100%	100%	100%
NAS-Wide Implementation (For ADS-B)										
Commercial	1%	17%	33%	50%	67%	83%	100%	100%	100%	100%
Air-Taxi	1%	13%	25%	38%	50%	63%	75%	88%	100%	100%
General Aviation	3%	7%	14%	22%	29%	35%	41%	47%	53%	59%

NAS-Wide Cumulative Equipped Aircraft

Commercial	42	1,433	2,962	4,594	6,332	8,182	10,150	10,493	10,848	11,214
Air-Taxi	391	647	1,309	1,985	2,678	3,386	4,110	4,850	5,606	5,671
General Aviation	5,948	14,019	28,323	44,960	60,714	73,593	86,750	100,145	113,803	127,729
Total	6,380	16,099	32,593	51,539	69,724	85,161	101,010	115,487	130,257	144,614

- Rates shown above are for UAT in Capstone and 1090 in ORV and NAS-Wide
- Equipage rates are assumed to vary for different links primarily due to cost

Assumptions - Enhancement 1 & 2

- Accident, injury / damage rates, and fleet mix are based on analysis of NTSB accidents.
- Accidents per 100,000 operations and the costs per accident were calculated for the following types of aircraft: Air Taxi, GA and Air Carrier.
- Alaska has a 3.3 percent higher rate than the national rate of weather related accidents (on average).
- 63% of CFIT accidents involve weather. Those accidents are removed from the FIS-B benefits pool.
- TAWs will be required for all turbine powered aircraft with 6 or more passengers and any 121 certified aircraft -- CFIT benefits do not include estimates for those aircraft requiring TAWs.
- Savings are calculated by applying the projected number of fatalities, injuries, aircraft damage and loss to an expected effectiveness and equipage.

Safety: 1 - FIS-B

- It is assumed that FIS-B and CFIT share a portion of the CFIT benefits pool.
  – 63% of CFIT accidents involve weather. To avoid double counting, they are not counted here but are considered under CFIT benefits
- Equipage for FIS-B will be mainly for Part 91 and 135 aircraft
- FIS-B effectiveness would prevent 25% of weather accidents

Weather Safety Benefits
(2002-2011)

	Constant $M	LD: AK	NAS
	Benefits Pool	$ 896	$ 9,438
Minus	Existing/Planned Capabilities (CFIT)	$ 609	$ 2,916
Equal	Remaining Pool	$ 287	$ 6,522
	Effectiveness (25%)	$ 72	$ 1,630
	Equipage Factor	$ 33	$ 518

* Benefits Pool Overlaps with CFIT Ben Pool
* Benefits for NAS do not include AK
- they are additive

Safety: 2 - CFIT

- It is assumed that SF21 and TAWS share the remaining unclaimed CFIT benefits pool.
  - TAWs will be required for all turbine powered aircraft with 6 or more passengers, and any 121 certified aircraft.
  - There is an overlap with weather accidents as well Those accidents are counted here and removed from weather.
- CFIT will have an assumed effectiveness rate of 75%
- Equipage for CFIT will be mainly for Part 91 and 135 aircraft.

Terrain Awareness Benefits (2002-2011)

	Constant $M	LD: AK	NAS
	Benefits Pool	$ 966	$ 4,628
Minus	Existing/Planned Capabilities (TAWS)	$ 94	$ 683
Equal	Remaining Pool	$ 873	$ 3,945
	Effectiveness (75%)	$ 654	$ 2,959
	Equipage Factor	$ 297	$ 886

* Benefits Pool Overlaps with FIS-B Ben Pool

* Benefits for NAS do not include AK
- they are additive

Combined Analysis of Enhancements 3 & 7

Efficiency

- Improved Terminal Operations (Enhancement 3), and Enhanced Surface Surveillance for the Controller (Enhancement 7) have inherent interdependencies between:
  - The terminal and surface domains
  - Arrival/departure changes
  - Demand for service and airport capacity
- Data constraints
  - Available data do not capture the above interdependencies
  - Surface taxi-time benefits interact with benefits derived while the aircraft is still airborne (during final approach)

Assumptions - Enhancements 3 & 7

Reduced Longitudinal Separations

- Benefits are derived from increased acceptance rates (airport capacity) due to ADS-B
- For the NAS, only the top 3 consecutive hours of airport demand were included in this analysis. For LD, all relevant peak hours are considered for cargo and NWA
- Three scenarios are considered:
  - Baseline: Current wake-vortex separations + 25-27 second-buffer (varying by aircraft type combination)
  - ADS-B equipped aircraft: Current vortex separations + 17-19 second-buffer (30% reduction)
  - Upper bound: Current wake vortex separations (no buffer)
- Airport efficiency is determined by the probability density function of inter-arrival spacing and wake-vortex separations
  - Increased acceptance rates are translated into delay savings

Assumptions - Enhancements 3 & 7 (Cont'd)

- ADS-B equipped aircraft
  - Airport capacity during MVRF days can be equivalent to that of VFR days (Enhancement 3.1.)
    - Improved Inter-arrival spacing will decrease arrival delays
  - Improved inter-arrival rates will impact the departure queue by increasing total airport capacity
    - Improved arrival rates reduces delays due to waiting in queue (where it exists)
    - Reduced taxi-out delays as a function of taxi-out queue
- Limited Deployment
  - All three airports in the ORV are considered
  - Cargo operations for Airborne Express (ILN), Federal Express (MEM), and UPS (SDF), and commercial operations for NWA are considered

Supporting Information

- Six points of reference constitute the framework of the analysis
  - Memphis Capacity Study (1997)
  - Lockheed Martin ATMP Study (1996)
  - CTAS Error Sensitivity, Fuel Efficiency and Throughput Benefits Analysis (July 1996)
  - Potential NPV for a Cargo Airline Investment in ADS-B Avionics Equipment: A Preliminary Analysis - George Mason University (March 2000)
  - CAASD Enhanced Visual Approach Study (April 1999)
  - Queueing model developed by ASD-430
  - APO ASDE Study (1993)

Enhancements 3 & 7

- Maximize hourly acceptance rates by reducing inter-arrival/departure spacing
  - Reduced arrival delays (ADOC)
- For LD, peak-hours are considered for cargo and NWA: MEM (4 peaks), and SDF (2 peaks)
- For NAS-wide, only one peak hour (plus the preceding and following hour) are considered for commercial and cargo aircraft at the top ***65 airports***
- The effectiveness rate is estimated as a function of the different scenarios
- A queueing model is used to estimate the impact of increased acceptance rates on delays

Efficiency Benefits (2002-2011)

	Constant $M	LD: ORV	NAS*
	Benefits Pool	$ 365	$4,000-$5,700
Minus	Existing/Planned Capabilities	$ -	$1,000-$3,000
Equal	Remaining Pool	$ 365	$3,000-2,700
	Effectiveness	$ 197	$1,600-$2,200
	Equipage Factor	$ 186	$900-$1,600

*** NAS = Top 65 airports only**

Safety: 4 - Enhanced See and Avoid

- Accident rates for the state of Alaska were derived from accident data for the period between 1990 to 1998.
- Most Mid-Air Collisions are Part 91, in local area with no flight plan.
- 11 midair collisions occurred in Alaska during that 8-year timeframe (aircraft-to-aircraft collisions)
- Based on forecast number of operations in Alaska during the analysis period, 18 mid-air accidents are expected to happen - resulting in 30 fatalities.
- System effectiveness is assumed to be:
  – 75% with CDTI & Conflict Detection
  – 100% with CD and Resolution
- Figures are based on NASDAC data and APO values

Safety: 4 - Enhanced See and Avoid

- 80% of midair collisions involve aircraft operating under Part 91 operations (GA)
- Equipage rates are adjusted to account for the fact that avoided accidents can be attributed not only to ADS-B-equipped aircraft, but also to their ability to see other transponder-equipped aircraft
- A 75% effectiveness is based on CDTI only. CD&R increases effectiveness to 100% by FY05

Collision Avoidance Benefits (2002-2011)

	Constant $M	LD: AK	NAS
	Benefits Pool	$ 91	$ 863
Minus	Existing/Planned Capabilities	$ -	$ 16
Equal	Remaining Pool	$ 91	$ 846
	Effectiveness	$ 85	$ 790
	Equipage Factor	$ 48	$ 346

Efficiency Assumptions - Enhancement 6

Efficiency:

- ADS-B with moving map display in the cockpit is expected to render taxi-time improvements
  - Improved surface navigation from the gate to departure runway, or from the arrival runway to the arrival taxiway is assumed to reduce unimpeded taxi-times by 5 % for those operations that do not experience taxi-queueing delay
  - Unimpeded taxi-out time is defined as the taxi-out time under optimal operating conditions
    - It is measured as:
      - Bottom 15th percentile of taxi-out time for busy airports
      - 50th percentile of taxi-out time of all other sites
  - It is assumed that the best-quartile of taxi-times cannot be improved

Efficiency: Enhancement 6

- Benefits pool is calculated as a function of:
  - Normally distributed taxi times
  - Unimpeded taxi times
  - Number of operations
- NAS-Wide operations considered:
  - 56% of arrivals do not experience taxi-in delays
  - 40% of departures do not experience taxi-out delays
- LD operations considered:
  - 59% (MEM), 64% (SDF) of arrivals do not experience taxi-in delays
  - 39% (MEM), 39% (SDF) of departures do not experience taxi-out delays
- Effectiveness is estimated at 5%

Efficiency Benefits (2002-2011)

	Constant $M	LD: ORV	NAS*
	Benefits Pool	$ 210	$ 10,894
Minus	Existing/Planned Capabilities	$ -	$ -
Equal	Remaining Pool	$ 210	$ 10,894
	Effectiveness	$ 10	$ 545
	Equipage Factor	$ 7	$ 337

*** NAS = Towered Airports only**

Enhancement 6&7 Safety Benefits Background

- The SF21 Benefits Team considered Surface /Approach Operations and Airport Surface Display to the Controller (Enhancements 6 &7) to have common safety relationships in the terminal area and proposed merging them for this CBA to the SF21 Select Committee. The committee approved combining the benefits analysis of Enhancements 6 & 7.

- In addition to combining Enhancements 6 & 7, the methodology accounts for the impacts of existing and planned capabilities (such as RIRP) on surface safety.

- The Runway Incursion Reduction Program (RIRP) Analysis Team completed a thorough assessment of runway accidents in the NAS. Based on the site-by-site findings of this work, the benefits pool for MEM, ILN and SDF as well as the NAS-wide runway safety pool were derived.

- The SF21 benefits team also completed an assessment of surface accidents not included in the scope of the Runway Incursion Program. These accidents occurred on the surface airport, but off the runway, and involved at least one aircraft. The forecasted savings for avoided non-runway surface accidents translated into $40M for the NAS over the relevant 10-year period.

Safety Assumptions -Enhancements 6 & 7

Effectiveness:

- It is assumed that SF21and RIRP Phase II share the remaining (unclaimed) surface benefits pool
- Investment decision JRC to approve ASDE-X quantities is expected in Summer 2000. This may impact the benefit estimates for SF21 surface safety enhancements. Phase II RIRP (distinct from ASDE-X) to be identified and confirmed by ATS-20

ASDE/ASDE-X Sites (95%)

- Existing/Planned capabilities (85%)
  - ASDE + AMASS/ASDE-X are assumed to be 75% effective based on existing studies: RIRP, APO ASDE Study, MIT Lincoln Labs Study
  - RIRP 2 is assumed to have a 10% incremental effectiveness over and above ASDE/ASDE-X*
- CDTI in the cockpit is assumed to have a 10% incremental effectiveness over and above existing ASDE/ASDE-X systems

* RIRP II is ***not*** considered in Limited Deployment

Safety Assumptions -Enhancement 6 & 7

Non-ASDE/ASDE-X Sites (95%)

- RIRP II is assumed to have 47.5% effectiveness
- Combined effectiveness of ADS-B to the controller and the pilot is assumed to have 47.5% effectiveness

Effectiveness Summary

LD

$$\text{Effectiveness} = 0.2\,(BP_{\text{ASDE/ASDE-X}}) + 0.95(BP_{\text{Non-ASDE/ASDE-X}})$$

NAS

$$\text{Effectiveness} = 0.5[\,0.2\,(BP_{\text{ASDE/ASDE-X}}) + 0.95(BP_{\text{Non-ASDE/ASDE-X}})]$$

BP = Benefits Pool

Safety: Enhancements 6 & 7

- It is assumed that SF21 and RIRP Phase II share the remaining (unclaimed) surface benefits pool
- A programmatic allocation of 50% to each program is used to calculate benefits for NAS
- No programmatic allocation is assumed for LD

Surface Safety Benefits (2002-2011)

	Constant $M	LD: ORV	NAS *
	Benefits Pool	$ 9.0	$ 1,047
Minus	Existing/Planned Capabilities (ASDE/ASDE-X/RIRP 2)	$ 6.5	$ 867
Equal	Remaining Pool	$ 2.5	$ 180
	Effectiveness	$ 2.0	$ 127
	Equipage Factor	$ 1.5	$ 85

*** NAS = Towered Airports only**

Benefits Summary

(FY00-FY11) Constant $M

SF21 Enhancements	Safety Totals		Efficiency Totals	
	LD	**NAS-Wide**	**LD**	**NAS-Wide**
1) Flight Information Services - Broadcast (FIS-B)	$33	$551	-	-
2) Controlled Flight into Terrain (CFIT)	$297	$1,183	-	-
3) Low Visibility Terminal Operations (LVTO) & 7) Airport Surface Display for Controller	-	-	$186	$900-$1,600
4) Enhanced See and Avoid (ESA)	$48	$346	-	-
6) Surface/Approach Operations (S/AO)	-	-	$7	$337
6) Surface/Approach Operations (S/AO) & 7) Airport Surface Display for Controller	$1	$85	-	-
Total	$380	$2,165	$194	$1,237-$1,937

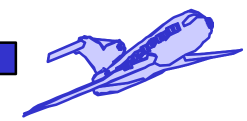
Limited Deployment Estimate Status

- ROM estimates completed

Benefit Categories	ORV	Alaska
Safety	Surface	All Domains
Efficiency	Terminal/Surface	TBD

- Additional elements to be considered
  - Costs
    - March 15 action item from the SAT
    - Avionics costs (NWA)
  - Benefits
    - Business Case
      - Cargo Airlines
      - NWA
    - Passenger Value of Time (PVT)

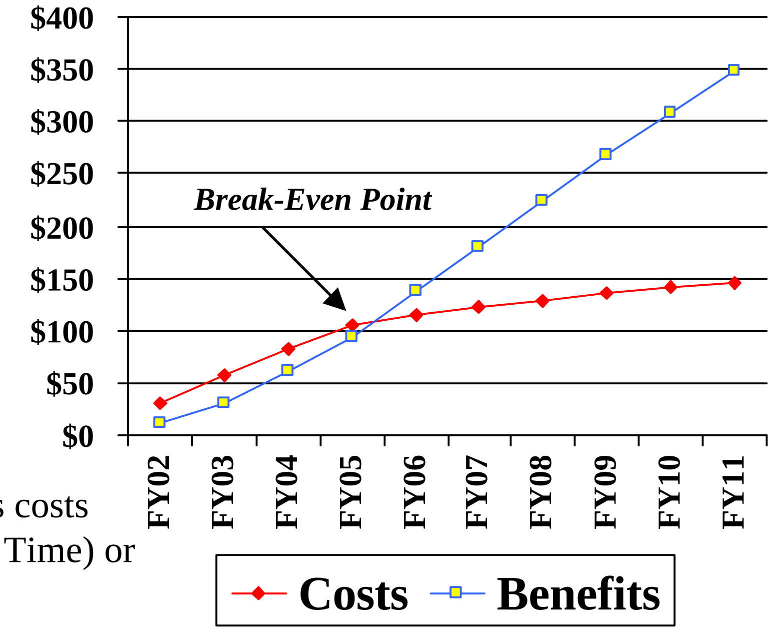
Summary of SF21 Cost/Benefit Estimates



$PVM

	ORV	AK	LD
Cost [1]	$39	$107	$146
Benefits [2]	$114	$233	$347
NPV	$75	$126	$201
BC	2.9	2.2	2.4

Break-Even Point



1.- F&E and O&M cost estimates do not include user avionics costs

2.- Benefit estimates do not include PVT (Passenger Value of Time) or User Business Case

- Major changes in benefit assumptions
  - Assumes NWA equips at MEM at the same rate as FEDEX
  - Increased safety effectiveness for CFIT , and Enhanced See and Avoid
  - Includes taxi-in/out efficiency benefits
- Updated cost estimates

Next Steps

- May 4, 2000
  - SF21 Report
    - ROM estimates
    - Selected Enhancements/Applications
  - Analysis Plan for next phase
    - Additional Metrics/Enhancements
    - Integration with Op. Evals/Simulations
- December 2000
  - Refinement of LD and NAS-Wide estimates
    - Revalidation of safety data
    - Revalidation of key assumptions, e.g., effectiveness, equipage
- June 2001
  - Link decision
- September 2001
  - Limited Deployment JRC decision